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ABSTRACT

The assigned readings for a graduate survey course in information science, including complete books, journal articles, and periodicals, were microformed and made available to 11 students, together with individual microform readers for home use. The microform use patterns and classroom performance of these students was determined and compared with the information acquisition patterns and performance of a control group. Motivation for microform use was derived solely from the convenience aspect of a home microform reader and from the students' perceived value of complete information availability through microforms; hardcopy materials were always available on the same basis as utilized by the control class. The overall student response to the microform system was positive; microforms were used continuously by students over the entire period of the experiment. A conclusive majority said that the home reader and the microfiche materials fulfilled their home study needs. Tests of student performance showed that microform presentation did not interfere with the acquisition of basic factual information. Students criticized the upright screen position which made note-taking difficult, the lack of a consistently clear focus, and inadequate indexing within the microform materials. (Author/JY)

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FINAL PHASE REPORT

AN INVESTIGATION OF THE ENVIRONMENT FOR EDUCATIONAL MICROFORM UTILIZATION

(Continuation of Contract No. OEC-0-8-080826-4648(095)

PHASE I

"STUDENT USE OF CLASSROOM MICROFORM IN SUPPORT OF A SURVEY COURSE"

Robert Grausnick
and
James P. Kottenstette
Denver Research Institute
University of Denver

30 April 1971

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Microform Data Systems, Inc., provided both the filmed materials and the reading equipment used in this work. The interest and professionalism of this organization added greatly to the conduct of the experiment.

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SUMMARY

This phase of the research in educational microform utilization, conducted at the University of Denver, explores the feasibility of direct classroom support using microform. The study here reported examines student behavior and identifies user requirements when microform was employed as the primary medium of communication in support of a survey-type course.* A graduate course, entitled "Information Science and Technology" provided the environment in which frequent and continued microform use by a student group was observed. The question: "Can students routinely utilize a microform presentation to meet their perceived information needs?" was central to the research.

Some 5500 pages of information, from 39 sources, including complete books, journal articles, and periodicals, were filmed and made available to 11 students, together with individual viewers (film readers) installed in their residences.

The microform use patterns and classroom performance of these students was determined and compared with the information acquisition patterns and performance of a control group. The control group utilized hardcopy materials available through the "reserve system" of the University Library. Motivation for microform use was derived solely from the convenience aspect of reader availability and students' perceived value of complete information availability through the microform; hardcopy materials were always available on the same basis as utilized by the control class.

The major result of the study is that most students can and did use the microform system routinely over a 10-week period. Further, the experiment demonstrates that microform can compete with hardcopy forms when a "value added" is achieved through the microform system. In this experiment, the "value added" was essentially complete information availability on an individual basis.

The report considers a number of important considerations in educational microform utilization ranging from the impact of the

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* Complementary research has been conducted in support of a "content" course. The report is identified as: Phase II, "Student Use of Classroom Microform in Support of a Content Course" (in press).

microform on study habits to student insights on system optimization. However, the significant accomplishment in this work is the demonstration that microform can play an active role in the educational process at the individual level, in addition to its present institutional role.

INTRODUCTION

For the past three years, the Denver Research Institute has conducted an extensive research program which was designed to explore applications of microforms in colleges and universities. While the "administrative value" of microforms is broadly recognized, the approach selected to implement this program focused upon the needs of the student user. The identification of these needs, together with a careful evaluation of the student-viewer interface as reflected in performance, preference, and attitudinal characteristics, has been a major goal of the research. Results obtained from the early phases of this program provide several insights which are essential in understanding the focal considerations of the present study.

Background

Kottenstette (1969) determined in a reading experiment that there are no fundamental physical or psychological barriers to the utilization of microforms in the communication of information that the student customarily encounters in hardcopy.[1] Students are able to preserve skill levels (reading rate and comprehension) when utilizing machine presentations of both descriptive and abstract materials which reflect various levels of difficulty. In addition, it was found that student performance is independent of reduction ratio (examined at 40X, 115X, 150X) and virtually equal to that obtained using hardcopy presentations.

Secondly, it has become obvious that screen presentations of educational materials can be of excellent quality throughout a wide range of reduction ratios up to 150X. In fact, an image presented at 150 times magnification compares favorably in readability with the original hardcopy material that was filmed. This means that educational applications of ultrafiche are not limited by the present state of reproduction technology. They are limited, however, by the requirement that a "machine-reading" application must have intrinsic value to the student, and not be applied solely because of certain administrative virtues.

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[1] "An Investigation of the Characteristics of Ultrafiche and its Application to Colleges and Universities," by James P. Kottenstette, DRI, University of Denver, Denver, Colorado, August 1969. (For the U.S. Office of Education, Bureau of Research, Contract OEC-0-8-080826-4648(095)).

Finally, as the data obtained from these earlier studies were analyzed, it became apparent that the possible educational application of microform could be quite inclusive rather than restricted to specific "areas" of application such as library reference materials.

Microforms' Role in Education

These results all support a basic contention that microforms could very well play a valuable and expanding role in educational pursuits, and in the educational process itself. However, microforms, as presently encountered in the institutional setting, serve a limited user group and the use is exceptional rather than routine. This distinction between exceptional and routine use is an essential one. Microform materials are widely distributed in the educational environment at this time, but for purposes which are generally consistent with limited usage: e.g., research, archives, back-issue maintenance, storage, etc., and with a limited user group.

A major postulate of this report is that the phrase "microforms in education" carries the implicit idea of "broad usage on a routine basis". This emphasis on routine use as an application criterion necessitates a more detailed examination of the environmental considerations involved in the implementation of a microform system. An application anticipating exceptional or restrictive use is not required to respond to the entire range of considerations that are involved in an application based on routine use in which repeated and continuing use is implicit; exceptional use implies a great need and high motivation which can overcome system defects. In normal educational applications, on the other hand, the primary motivation for using a microform presentation can arise only from the information needs of the student as perceived by the student. The continuing nature of these information needs does not equate with sustained high motivation of the individual student.

Routine use and a broad base of users proposed for educational microforms requires that the student himself be the primary focus of any microform system development for educational application. If the role of microforms in education is to improve, the concepts inherent in developing a broad user base specify the point of departure from present limited systems. One major step in this departure is the development of operational or real-life situations in which microforms can be used to support a range of educational activities. A major student contact point, examined in order to recognize the factors which may positively or negatively affect routine use, is the classroom.

Routine Use Supporting the Classroom

The present study phase was designed to shift the experimental emphasis of the educational microform investigation from the man-machine interface to routine microform utilization in direct support of educational activity. The classroom situation provides a point of departure because student information needs, based on the instructor's definition of course material, modify the user-viewer interaction which was studied in the laboratory. This report considers microform use, in one type of classroom situation, in which a survey-type course was selected to provide experimental insight into the following considerations:

1. What is the basis of user preference characteristics when reference materials are available in both microform and hardcopy; will the students use a microform presentation routinely when the only motivation for its use arises from the perceived information needs of the student?

2. What effect, if any, does routine utilization of microforms have on student performance as reflected in examination results and classroom participation?

3. What are the factors operative at the student-machine interface which create negative attitudes toward the use of microforms and which positively or negatively affect routine utilization?

4. How does the organization of material on the fiche affect study habits and student preference?

5. Do the physical characteristics of the viewer (machine) cause discomfort or fatigue leading to disuse?

6. Does the viewer-fiche system alter student study methods in significant ways?

7. What role does the information unit itself (the microform) play in meeting a student's need for complete information availability?

Course Selection

The selection of a course to be used in this phase of the investigation was made after careful consideration of several important variables. First, a graduate-level course was desired to help insure the maturity and stability of the student subjects with regard to class attendance, level of participation and cooperation. In addition, a graduate-level course in a narrowly defined academic discipline allows reasonable homogeneity of previous college experience, current course load, and professional interests.

Secondly, it was thought that a required course at this level would effect a more accurate estimation of the enrollment than a non-required or elective course. In this regard, an anticipated class size of approximately 30 students each quarter was appropriate for the original experimental design.

The structure and content of the course itself were also important considerations. For the planned experimentation, the course structure should allow active participation by students in the classroom as opposed to a course based entirely on a lecture format. In addition, the content and reading requirements should emphasize the utilization of multiple sources rather than concentration on a single primary textbook. In other words, it should be a "survey" course in which the student need only demonstrate familiarity with a wide range of materials as opposed to a "content" course* which requires that the student analyze and retain course content.

Finally, the experimental design required that, for control purposes, the appropriate course be taught in two consecutive quarters by the same instructor. Of necessity, the full cooperation of the instructor was also a requirement of primary importance.

The course which best met these requirements was entitled "Information Science and Technology", taught in both the Winter and Spring quarters in the Graduate School of Librarianship, University of Denver. The course focused on information science and required extensive reading from a broad selection of sources including conventional texts, reserve books, periodical articles, and research reports.

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* See Final Report, Phase II, "Student Use of Classroom Microform in Support of a Content Course", covered by the same contract as this present report (in press).

Course requirements included two examinations and a research paper on a topic relevant to class discussions. Classroom activities centered around lectures and discussions, presentations on research paper topics by selected students, guest speakers, and an occasional field trip. Of the 21 meetings allotted each quarter for classroom activities, 10 were devoted to lecture by the professor. In all of the meetings, however, active participation by the students in discussions was encouraged and often solicited. Students who successfully completed the requirements received three quarter-hours of credit.

Qualification

This introduction to the concepts and scope of the reported experimentation would be incomplete without the following qualification being well understood by the reader: the research reported upon was not intended to be an educational performance comparison nor to be a controlled behavioral study. The objective of this work was to provide first insights into questions of "broad and routine use" of educational microforms.

METHODS

Materials and Equipment

The viewers utilized in the experimental phase of this program were obtained from the Microform Data Systems Company, Inc., of Palo Alto, California, which also provided the necessary filming. These viewers were MDS-330 prototype models (Figure 1) which operated at 150X magnification. There were several considerations involved in the decision to utilize this reduction ratio.

The selection of a type of microform for any application should be based primarily on the nature of the required information and on the constraints and limitations of the form itself. Previous studies[2] conducted by the Denver Research Institute have demonstrated that although a quality differential is detectable in individual character recognition or visibility at high reduction ratios, a quality image presented at 150X magnification compares favorably in readability with the original hardcopy. Most educational applications of microforms are consistent with high readability of the machine presentation and these early studies demonstrated that current technology can preserve readability at high reduction ratios.

Another study examined the role of reduction ratio while comparing reading performance on viewers with that obtained on hardcopy. Reading rates and comprehension were found to be essentially equal to those obtained on the hardcopy as well as being independent of reduction ratio.

The implication of these results is obvious; if reduction ratio itself is not a limiting factor, the selection of the microform used should be based on the characteristics of the information to be reproduced. Since the materials for this course were gathered from several volumes and periodicals, the ultrafiche form was selected in order to preserve the integrity of the filmed documents (book-length materials, specifically). The potentially high frame-density of the ultrafiche form permits entire works, or multiple related works, to be placed on a single fiche. In addition, the ultrafiche has both vertical and horizontal components of image placement for the organization of information, which permits the user rapid access to any of these pages merely by moving the fiche slightly.

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[2]Ibid.

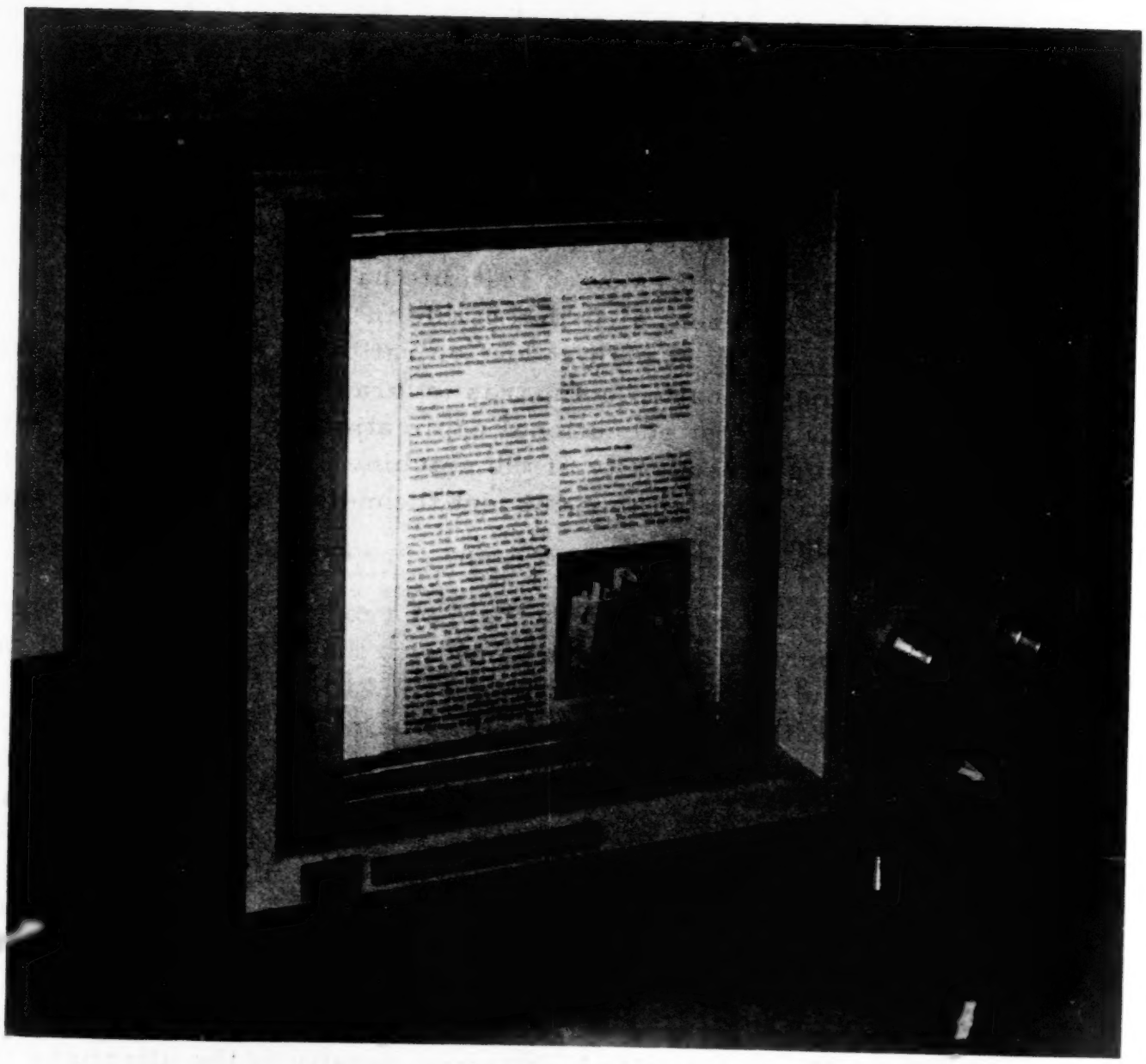

Figure 1. MDS-330 Viewer Used in Students' Homes

The particular fiche form produced for this experimentation was the "ultrastrip," a 35mm film strip approximately six inches in length (Figure 2). Each of these strips contained five segments or units of information. A segment consisted of thirteen rows and twenty columns for a potential capacity of 260 images.

This format was used in the present study to present approximately 5500 pages of original material, necessitating six film strips. Required readings for the course were selected from 16 volumes and 23 periodicals and/or research reports. A list of the course material filmed with the publishers' permission is presented in Appendix A. Information was organized on the fiche by column, rather than by row. This change in the image sequence facilitates the location of information within the fiche and reduces the annoyance of reframing each image; that is, it makes precise framing (side-to-side) possible and vertical framing arbitrary (only the column need be framed).

Book-length materials were organized in the order in which the instructor required that they be read. For example, reading number 1 was located on strip 1, segment 1; reading number 2 was located on strip 1, segment 2; and so on through the first five strips. When a reading was taken from a book, the entire volume was filmed with the rationalization that the additional material might be useful to the student for classroom discussions or research papers, just as the entire volume would be available to the student in the Reserve Room. Each segment of a strip contained only one volume. If the length of the volume exceeded 260 pages, the remainder was included on the next segment, but in no case was material from more than one title included on a single segment. Periodical and research report articles were organized on the sixth strip in the order in which they were to be read. The separation of these articles from the textual materials was based on filming convenience and the potential for improved retrieval characteristics through aggregating these materials on one film strip.

It should be emphasized that the novel form of the microimagery, i.e., the strip as opposed to a card-type fiche, is totally incidental to the essential research questions. These questions focus on the routine use of a microform presentation to satisfy student information needs arising in a survey-type classroom environment.

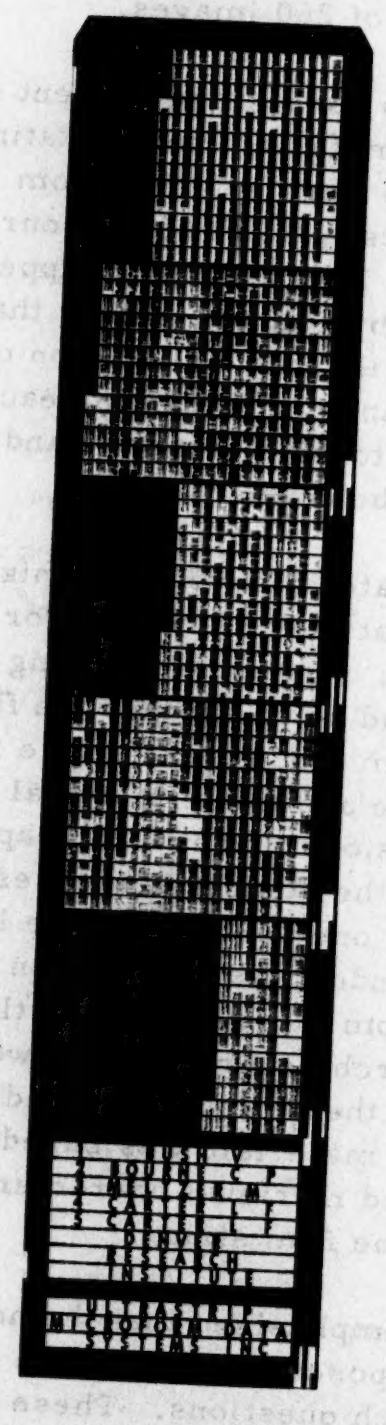

Figure 2. Actual-Size Photograph of an "Ultrastrip" (150X) Produced By Microform Data Systems, Inc., Palo Alto, California

Experimental Design

The experiment was conducted in two parts, during the Winter and Spring quarters, respectively, of the 1969-70 academic year.

The first 10-week period of experimentation was used primarily to collect basic information from the Winter quarter class in order to reference student response in a normal, unaltered survey course. This class acted as a control and reference group by utilizing conventional textual materials, periodical articles, and research report literature in their hardcopy form. The normal method for obtaining hardcopy materials for a course having a large number of required readings is to utilize the Reserve Room system of the University Library. Copies of each required reading are placed in the Reserve Room and may be obtained for limited time periods by the students.

Information regarding course examination results, level of effort over time, Reserve Room usage and classroom participation was obtained from this class through observations and measurements tabulated throughout the quarter. Every attempt was made to have this classroom situation as uninfluenced by outside variables as possible. This was accomplished to the extent that the participants in this class were unaware of their involvement in this research effort until the course was completed.

The second 10-week experimental period involved the collection of comparable data from the Spring quarter class. However, for this class, the normal procedure of obtaining materials through the Reserve Room system was altered by the introduction of microform viewers and materials to the students. These students were fully aware that theirs was an experimental class and of their involvement in the research program. The manner in which these materials were utilized, as well as the methodology of data collection, will be detailed in another section.

An examination of the demographic composition of this Spring class indicated that, except for the total number of students involved, it was very similar to that of the Winter quarter class. This does not mean, however, that it is necessarily comparable to similar classes taught in other professional disciplines. The most obvious difference would appear to be the ratio of male to female students (which is also characteristic of the Graduate School of Librarianship in general). Of the 34 student participants in the Winter quarter class, only five (15%) were male. In addition, over one-third of the students in this class

were over 30 years of age and contributed to a mean group age of 29.7 years. Ten (30%) were married, 18 (53%) were single, and 6 (17%) did not indicate their marital status.

The Spring quarter class (16 students) was very similar to the Winter quarter class in every aspect of composition. For example, only two of the 16 students (12%) were males; the average age for this group was 28.4 years; 37.5% of the students were over 30 years of age; six (38%) were married and 10 (62%) were single.

The demographic similarity between the two groups facilitated the comparisons which were necessary to assess the effects of introducing the microform system into the classroom situation.

The Research Objective and the Strategy. The essential question explored in this study was "How useful is a reader-fiche system in support of one type of student information need?" The approach chosen was to gather basic data which was either directly or incidentally related to the required readings expected of the students (the course syllabus). The first step was to establish "base line" data. This was accomplished during the Winter quarter when the students performed "as usual". Data was developed which showed the patterns of use for the hardcopy materials maintained on reserve; classroom participation measures were developed, and examination segments covering the required readings were created for both a mid-term and a final examination.

The next step was to obtain the same measures during the Spring quarter when the students were using the viewer-fiche system.

Two essential conditions were imposed on the conduct of the study and should be noted: first, availability of hardcopy materials was not limited in any way during the Spring quarter; secondly, no incentive or inducement was used to enhance the use of the microform beyond the fact that the system was made individually available.

It was originally anticipated that approximately 30 students would enroll in the course for the Spring term (34 students were enrolled for the Winter quarter), and that the course would be divided into two sections with approximately 15 students in each section. The members of one section were to be presented with viewers and microform materials to be used in students' residences, while the second group would obtain their hardcopy materials through the Reserve Room, as did students during the Winter quarter. The hardcopy section of the Spring

class would then be compared with the Winter quarter class to determine whether the "base line" had been shifted in some way. Given that it had not, comparisons would be made between the two Spring quarter groups.

Due to the unexpectedly small Spring quarter enrollment in the course (16 students), certain changes in the proposed methodology were necessary. The intra-class comparison was abandoned and only the two classes were compared. All Spring term students had the option of obtaining hardcopy materials which were available "on reserve" in the University library, or of utilizing the fiche form of these materials which was made available to each of them at the first class meeting.

This first class meeting was devoted entirely to a presentation of the proposed research program and a demonostration of the equipment to be used in support of it. The students became familiar with the viewer-fiche system; its size, space requirements, and operation. Throughout the discussion, the convenience of the viewer-fiche package and the complete availability of information were stressed. Students were assured, however, that their participation involved only accepting a viewer in their homes. If they found that they could not use it for any reason, or that they preferred not to use it, hardcopy materials were available for use in the normal fashion. No other incentives were offered to the volunteers.

Eleven of the 16 students in the Spring quarter class accepted a viewer in their residences.* A twelfth viewer was placed in the Microform Reading Room of the library for on-campus use. Installation of the home viewers was completed during the first four days of the quarter.

The Measures. In this study, three objective measures were developed to explore the effects of introducing the viewer-fiche system in the Spring quarter class.

1. Information Usage and Level of Effort Over Time. These variables were examined to compare the long-term routine use characteristics of the Spring quarter class (microform materials) and the Winter quarter class (hardcopy materials) in meeting identical course requirements. The data which comments on these variables were obtained from two sources: first, an "information-use form" was used to monitor hardcopy transactions in the Reserve Room of the library on

* 12 film viewers were available for the experimentation.

a daily basis during both quarters. These forms provided data concerning: (a) the duration of each Reserve Room transaction, (b) the number of transactions by each student, * (c) the author of the article being read, and (d) whether the students xeroxed any material. The students were requested to fill out a form at each and every Reserve Room transaction.

Each microform viewer used by the Spring quarter class was instrumented to record the frequency and duration of student usage. The meter readings which were taken in the student residences provided additional information concerning the level-of-effort-over-time and the information-usage variables. The first readings were taken at the time of the mid-term examination after the students had used the viewers for an average of 27 days. The second readings were taken 28 days later and the final readings were made when the viewers were removed from the students' homes.

2. Examination Results. Both classes were required to take two examinations, a mid-term and a final. The exams contained essay questions based primarily on lectures and classroom discussions, and true-false questions which dealt entirely with the required readings. The mid-term examination was administered during the fifth week of each ten-week quarter and the final examination was completed during the last class meeting. Since this study was primarily concerned with the acquisition of the basic factual information contained on the fiche, only the true-false sections of the examinations were considered relevant and included in the final results.

3. Classroom Participation. Each Winter and Spring quarter class meeting was monitored to determine whether the introduction of the viewer-fiche system to the Spring quarter class had any effect on classroom participation. In-class responses were recorded and assigned to the individuals who made them. A record was also kept of those responses which were relevant to or indicated a familiarity with the required readings. In addition, each response was placed in one of the following categories:

a. Orientation question; these were questions concerning the mechanics of the course itself, such as what the examinations included and which readings were required for the next meeting.

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* These data were recorded by the individual students anonymously.

b. Answers to direct questions from the instructor.

c. Questions or comments which contributed to class discussion.

In addition to these measures, a questionnaire designed to elicit student comments concerning the environment for information use, criticisms of the medium of presentation, and recommendations for the improvement of data acquisition was administered to both classes at the final class meeting. Eighty-five percent (85%) of the Winter quarter population (29 of 34 students) and 81% of the Spring quarter students (13 of 16) responded to the questionnaire.

RESULTS

Student Usage

Before the effects of introducing the viewer-fiche system to the Spring quarter class can be properly assessed, it must first be established that the students in the class did use the viewers routinely to meet the reading requirements of the course. Table 1 presents the averages of student estimates of the percentage of the required reading which was accomplished using various sources.

Table 1. Percentage Estimates of Required Reading Accomplished Through Available Sources

Source	Winter Quarter	Spring Quarter	Spring Quarter	
			With Readers	Without Readers
Reserve Room	83%	32%	21%	69%
Textbook	9%	7%	6%	9%
Other Sources	8%	1%	1%	2%
Reading Room Viewer		9%	7%	20%
Home Viewer		51%	65%	

The table indicates that during the Spring quarter 60% of the required reading was done using a viewer-fiche presentation, either at home or in the Microform Reading Room of the library. Students with home viewers did 72% of their readings using a viewer-fiche presentation and only 21% using the Reserve Room system. Data from the Winter quarter class indicates that normally 83% of the students' work would be done within the Reserve Room system. Spring quarter students also used the textbook and other sources less than students in the Winter quarter. These results confirm substantial use of the viewer fiche presentations by the Spring quarter class.

The subjective results presented in Table 1 are substantiated by the data on information usage which was obtained from the

"information-use forms" used to monitor Reserve Room transactions and from the frequency and duration meter readings taken during the Spring term; these results are presented in Table 2. Since the number of students represented by the data is different for each class, the most important parameter to be considered is hours of use per student. It should be noted that only 15 of the Winter quarter students regularly responded to the "control" forms associated with their reserve book use. This incomplete response by the class was anticipated but was accepted because of the risk of stimulating inflated or distorted use data. The pattern of use evidenced by these 15 students was assumed to be indicative of the class as a whole. During the Spring quarter, regular use of the control forms was achieved as a condition of student participation. Spring quarter students with home viewers averaged approximately 20 hours of use during the quarter as compared with an average of almost 11 hours of Reserve Room use by the Winter quarter students. This comparison supports the subjective data which indicates that Spring quarter students did indeed use the viewers in support of their coursework. The on-campus viewer also saw substantial use, although by only two students.

Table 2. Information Use Characteristics for the Winter and Spring Classes

	Winter (Reserve Room)	Spring Home Viewers
	n=15	n=11
Total Transactions	202	600
Total Minutes	9724	13,218
Total Hours	162	220
Minutes/Transaction	48	22
Hours/Student	11	20
Transactions/Student	13.5	54.5

Part of the difference in extent of usage between the two classes can be explained by examining what is done during a transaction because student study habits were affected by the different mediums of presentation. The Winter quarter class used the Reserve Room transactions

for both data acquisition and retention effort. That is, the material was transcribed into a form which could be studied at a later time through note-taking. In the Spring term, both the acquisition and re-study of materials could be done using the home viewers since all the required information was available to the students in fiche form. The distinction between data acquisition time and study time also was reflected in the number of transactions per student and the difference between the average length of a transaction for the two classes. These considerations will be further examined in a later section.

From these data it can be concluded that microform systems were used extensively by the Spring quarter students to meet course reading requirements. Having established this, other important considerations can be examined. First, does this data represent a sustained use pattern throughout the quarter? That is, did the students continue to use the viewer routinely after they had become familiar with all aspects of the viewer-fiche presentation. Second, did the long-term routine use characteristics of the Spring class differ from those of the Winter class? Finally, what effect did the use of microform materials have on the course performance of the Spring quarter class?

Sustained Use Patterns

Table 3 presents the average number of transactions per day per student and the average duration of use each day for each student as logged on home viewers during the three measurement periods in the Spring term. The time periods represented in the table reflect averages while the data itself is based on the actual number of days that each student had a reader in his home. These figures are nominal because installation and meter readings could not be taken for all students on the same day.

Table 3. Transactions per Day per Student for Spring Quarter Subjects and Viewers

Period	Number of Students	Transactions	
		Average Number	Duration (Minutes)
I (27 days)	11	1.3	25.5
II (28 days)	10	0.5	10.8
III (10 days)	8	1.2	35.1

An important feature of this table is that the data was based on a decreasing number of student users as the quarter progressed. One student discontinued use of the home reader after the first 27-day period complaining of headaches and a nauseous reaction to viewer use; the averages in the second time segment, therefore, are based on 10 rather than 11 students. Two other students discontinued use after the second meter reading; one student became seriously ill, the other changed residence and was unable to accommodate the viewer. Eight students used the viewer fiche system for the entire quarter. The first "casualty" points out that there are students in the university population who are unable to use a microform viewer; this fact was further documented by another student in the class who was unable to use the on-campus viewer for physical reasons. Both students who had adverse physical reactions to the screen presentation required glasses for reading purposes.

The above table indicates a use pattern which would be expected if the students had used the microform materials routinely in meeting the course reading requirements. The relatively high usage during the first 27-day period reflects a strong reading requirement in the syllabus and student preparation for the mid-term examination. Considering only the eight students who used the readers throughout the quarter, 252 of the total 493 viewer transactions (51%) were recorded during this time segment as well as 81 hours or 43% of the total 188 hours of viewer use over the quarter.

The lull during the following 28-day period represents a time when there were no examinations to stimulate required reading and a change in course emphasis to research paper preparation. Students concentrated their efforts toward preparation of research papers and many students utilized outside sources in this work. The time which was spent using the viewers during this period reflects the necessity of preparing only for daily discussions as opposed to regular acquisition of information to be studied for the final examination since these students had all readings for review purposes available in their homes. During this segment, only 60 hours and 156 transactions were recorded, representing 32% and 31% of the totals, respectively.

Data from the last 10 days of the quarter indicates student preparation for the final examination. During this period, 85 transactions accounted for 47 hours of viewer use.

An important comment concerning sustained usage is that the effort expended by individual students at the end of the quarter was greater than that observed at the beginning of the course when curiosity and novelty also contributed to the observed use. This is clearly indicated by the average time spent using the viewer per day per student during the final 10 days, which was greater than that spent during the first 27-day period. It can be concluded that, with the qualifications noted, sustained use of the viewer-fiche system was, indeed, achieved during this experiment as defined by the course reading requirements.

Routine-Use Characteristics

A comparison between the Winter and Spring quarter classes with regard to the frequency and duration of information utilization transactions revealed that the introduction of the viewer-fiche system to the Spring quarter class resulted in routine-use characteristics which differed from those of the Winter quarter class. Although the overall pattern of interaction, as dictated by identical reading requirements, was the same for both classes (and essentially identical to that described in the preceding section for the Spring quarter class), the complete availability of information to the Spring quarter class reduced the necessity for taking notes to acquire data. This resulted in shorter, more frequent transactions and in a different allocation of study time. In effect, data retention through note-taking, normally the most time and effort consuming aspect of meeting the reading requirements, was reduced by the fiche system, leaving more time for other activity.

Both classes required the same material in a readily accessible mode. For the Winter quarter class, this meant abstracting the material into a form which could be taken from the Reserve Room for review at a later time. Since no xerox copies were made by this class, it is hypothesized that the students' transactions involved data acquisition through note-taking, a time-consuming process. This would explain the fact that over the entire 10-week period, the average transaction for the Winter quarter class was 44.5 minutes in length, in contrast with 26.5 minutes for the total Spring quarter class and 25 minutes for the eight students who used readers throughout the quarter.

The Spring quarter class also took notes to some extent but data retention did not require that this be done since essentially all required materials were available in fiche form. Therefore, the average length of a transaction was significantly less for the Spring quarter class than for the Winter quarter class during the first two time periods considered.

The equivalence in transaction duration during the final time period is explained in part by the fact that the average length of a transaction increased for the Spring quarter class while it remained relatively stable for the Winter class. (See Figure 3.) This increase represents a review period prior to the final examination when more than one reading was reviewed during a transaction. Although the Reserve Room was used less frequently by the Winter quarter class during this time, when it was used, the same note-taking activity was involved.

This interpretation is supported by the data in Figure 4 which represents the percentage of the total time expended during the three periods by each group. Considering only the Winter quarter class, Figure 4 indicates that the greatest concentration of effort was during the first 27-day segment. This was a period of data acquisition during which much of the note-taking process discussed above took place. There was less need for this activity as the quarter progressed and data was accumulated. The final 10-day segment was used for review by both classes. However, the review procedure itself was somewhat different for the two classes. For the Winter quarter class, data acquisition from the readings was nearing completion at this time and much review was done on already acquired materials with less need for further Reserve Room transactions. In contrast, the Spring quarter class did their review work on the home viewers which were the primary source of review data. This difference in the review procedure between the two classes provides a partial explanation of the changing use profiles as the quarter progressed. In addition, as mentioned above, the average length of a Spring quarter transaction increased during the final 10-day period and this is also reflected in the differing distributions of class effort.

Examination Results

The results of the true-false sections of the mid-term and final examinations for the Winter and Spring quarter groups are presented in Table 4 which indicates that there were no significant differences among the groups in examination means or standard deviations. The means in all cases were essentially identical and, although the standard deviations were slightly larger for the Spring quarter groups, the differences were not significant and were an expected result of the reduced sample size.

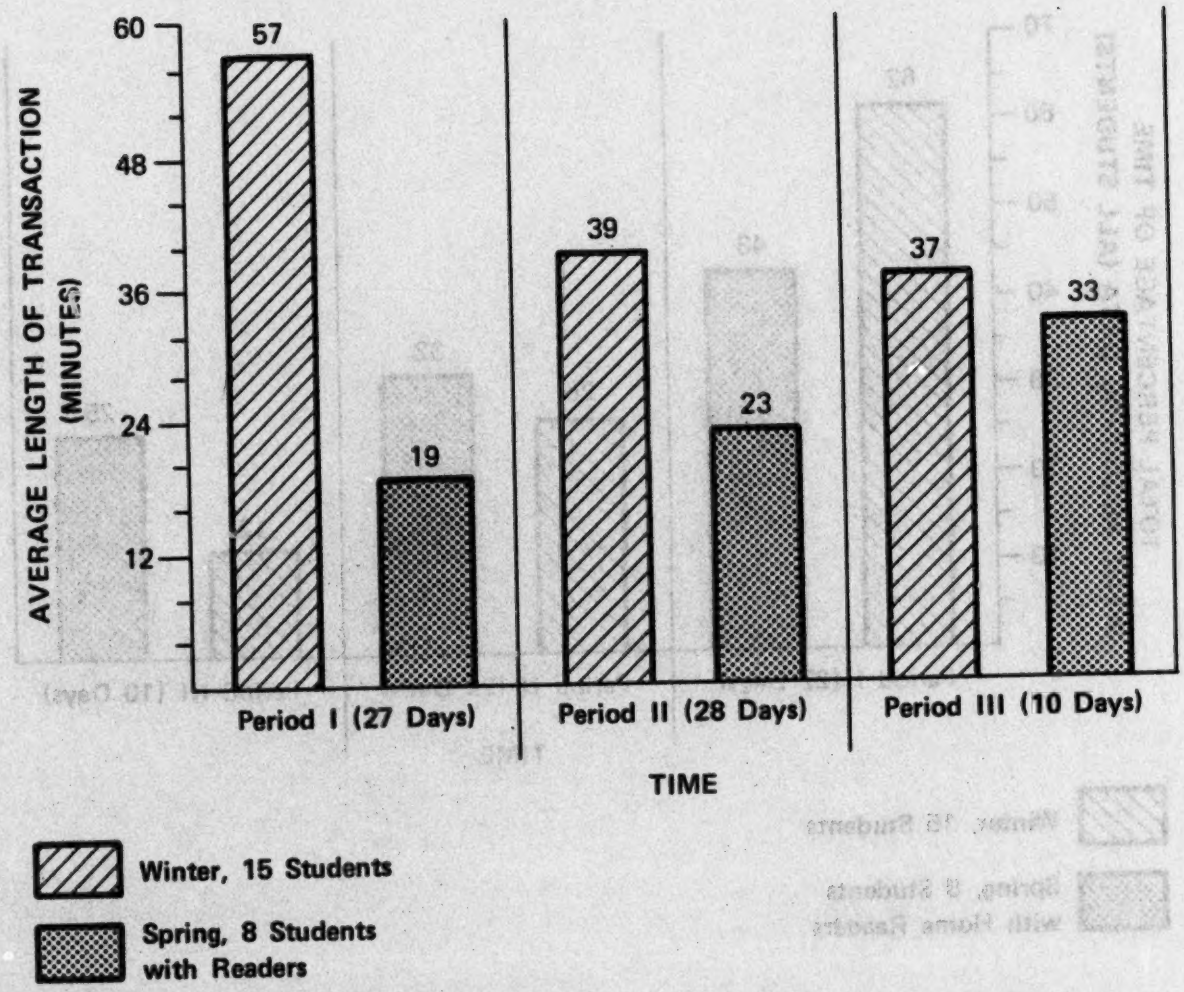

Figure 3. Average Duration of Transactions

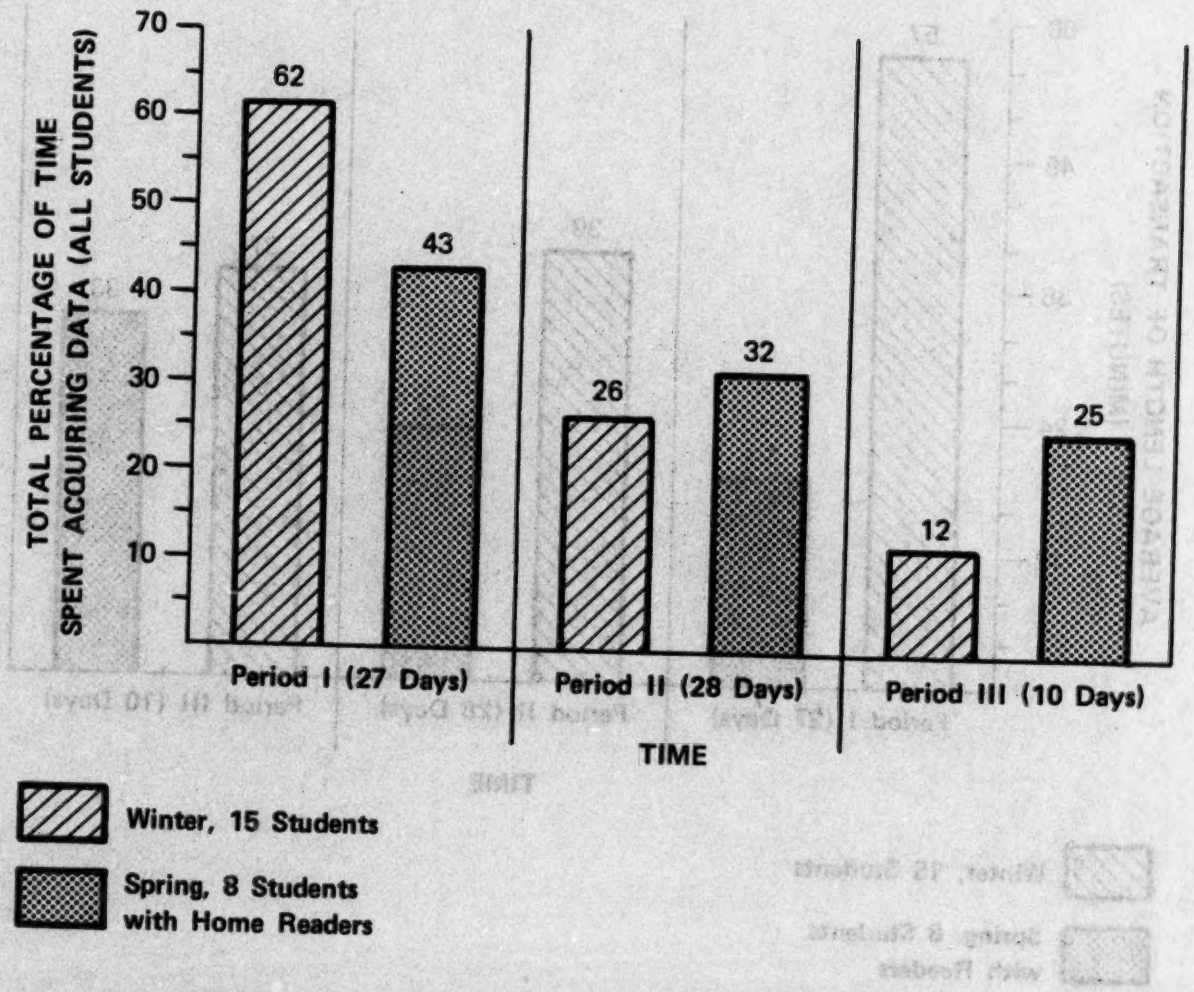

Figure 4. Percentage of Total Acquisition Time By Time Segment

Table 4. Examination Results

	Examination			
	Mid-term		Final	
	Mean	S.D.	Mean	S.D.
Winter quarter (n=34)	21.1	2.16	36.7	3.92
Spring quarter with viewers (n=8)	20.90	2.24	37.0	4.86

* Mean = correct respones, true-false sections (mid-term 25; final 50)

These results are consistent with earlier investigations of learning as a function of class size. Siegal (1960) and Macomber and Siegal (1965) concluded that class size, per se, does not affect students' acquisition of factual information. Their studies indicated that size of class made no significant difference in the kind or amount of learning which took place. The National Education Association (1968) states:

> "It appears that the teacher, his instructional methods and his personal outlook are important factors that make a difference as class size varies. If a teacher approaches a small class just as he does a large class, the measurable difference between the two groups should be negligible." (p. 36)

This type of identical instructor approach to both classes was included in the experimental design of the present study.

Since it is well documented that class size, per se, has no influence on learning, it is hypothesized that this variable was not operative in the present study; in other words, it is assumed that class size did not interact with the introduction of the viewer-fiche presentation to produce the Spring quarter examination results. Given this assumption, it can be concluded that the use of microform materials did not interfere with the acquisition of basic factual information.

Classroom Participation

There were observed differences between the Winter and Spring quarter groups in the pattern and amount of individual participation in

classroom activities. Over half of the Winter quarter class (59%) made fewer than five responses of any kind during the entire 10-week period in contrast to 12% of the Spring quarter students. Within this category, only one student in the Spring quarter class (6%) made absolutely no responses while 10 of the students (30%) failed to respond in the Winter. Only 15% of the Winter quarter class made 15 or more responses as compared with 25% of the Spring quarter class. In addition, the Spring quarter class averaged almost twice as many responses per individual student as did the Winter quarter class.

These participation patterns (see Table 5) comment on complete information availability and reflect a well-documented influence of class size. Many researchers (Bales, et al., 1951; James, 1951; and Miller, 1950; and others) have stated that the proportion of non-contributers increases as the size of the group increases; only the more forceful individuals are able to express their ideas and opinions in larger groups.

Table 5. Classroom Participation; Student Responses by Category

Category	Winter		Spring	
	Total	per student	Total	per student
Total Responses	228	6.7	198	12.4
Relevant Responses	12%	.82	12%	1.56
Orientation Questions	36%	2.38	36%	4.5
Answers to Direct Questions	13%	.88	15%	1.875
Comments and Discussion	47%	3.08	45%	5.5
Not classifiable	4%		4%	

The general effort expended each day throughout the quarter was greater for the Spring quarter students than for the Winter quarter students. Having complete information availability allowed the Spring quarter students to keep pace with reading requirements on a daily basis, since it facilitated data acquisition. In the larger Winter quarter class, individuals felt less need for daily participation which was actually hindered by the lack of information availability. In spite of these differences in daily contact, both classes were equally able to meet course examination requirements.

The types of response dictated by the required readings and classroom discussions were identical for the two classes. However, the average number of each type of response per individual was substantially greater for the Spring quarter class, as was the total number of responses per individual.

An assumption basic to this discussion is that a student must be informed in order to participate in relevant classroom activities. If this assumption is accepted, it can be concluded from the data presented in this section that the introduction of the viewer-fiche presentations to the Spring quarter class did not interfere with the acquisition of basic factual information. This conclusion is further supported by considering the eight students who used home viewers for the entire Spring term. These students averaged 15 responses per individual as compared with 12.4 for the total Spring quarter class. In addition, they averaged 3.125 responses which were relevant to the required readings as compared with 1.56 for the total class. Although they comprised only 50% of the total population, they contributed 67% of the total number of responses and 76% of the relevant responses. These figures indicate that perhaps even a stronger conclusion than the one given previously above is warranted. Spring quarter students with home viewers were more familiar with the required readings on a daily basis than students without viewers. That is, the acquisition of basic factual data was facilitated by the complete availability of information on the fiche presentations.

Subjective Evaluations

The three objective measures summarized above in the Results section clearly show that the viewer-fiche system was utilized effectively by the students in support of a "survey" type classroom situation. This experimentation provides an opportunity to gain additional insight into the questions surrounding the use of educational microforms because the students involved in the experiment are unique in their broad and continuing experience with the microform; experience was gained through their perceived information needs only, rather than from an administrative requirement or fiat. The eight students who used microform for a total of 188 hours during a 10-week period are, indeed, unique.

The subjective inquiry was concerned with the following questions; the summary statements were developed through a questionnaire technique and interviews.

1. Information availability as a motivation for microform use.
2. Study habits change.
3. Fatigue characteristics.
4. Fiche organization and format.
5. Student criticism and recommendations.

Information Availability. Four of the students thought that complete information availability offered by the system compensated for the difficulties encountered in using the viewer-fiche presentation, and only one student cited technical deficiencies in the system as too physically constraining for long-term use. Other student comments indicated that the information was not complete operationally and this was aggravating. Two out-of-print periodicals were not obtained in time to be included on the fiche, and some of the articles were not easily readable due to small original print size. Students were more annoyed by deletions than by not having any materials on fiche because of the required change in their study plans. But unreadable materials were especially annoying since students were not aware they had to obtain the materials elsewhere until they found the items unusable. In spite of the deletions, however, the overall student response to the viewer-fiche presentation was positive. Eight students in the Spring quarter class wanted to see continued or expanded use of this type of presentation though modifications in the viewer design would have to be made. Students generally thought it a convenient, novel approach to meeting course reading requirements and were especially positive toward having both the readings and the viewers in their homes. These students indicated the presentations adequately fulfilled home study needs for the course and the remaining students stressed the technical problems inherent in the viewers or the physical reactions mentioned earlier.

Approximately three out of four students in the Winter quarter class found it necessary to use outside sources in support of course-work in contrast to only one out of four in the Spring quarter class who found outside sources necessary. This indicates that the fiche presentation, in combination with the Reserve Room, was better able to meet student needs than the Reserve Room alone; it also comments indirectly on the availability of information in fiche form. This result

could be interpreted to mean that the Spring quarter class used the additional materials included on the fiche to prepare their research papers, but this was not the case; seven students in the class found that the additional material was not relevant to their paper topic. However, four other students did use these materials and felt that the concept would be an important tool if materials were selected carefully for this purpose.

Students were asked to comment on the viewer in the library and only two students commented positively; negative responses were evenly divided between those who indicated that since they had materials at home, their on-campus time was free to support other classes, and those who said if they were forced to work in the library they would use hardcopy. These results comment upon the efficient use of time in education. On-campus time could be devoted to activities which could only be done on-campus. Those students most impressed with the convenience of the home viewer and fiche lived furthest from the campus or were employed and had limited on-campus time available for study or review. The convenience of having the viewer at home overcomes some of the difficulties inherent in its use; without this convenience, system defects are too troublesome when the familiar hardcopy is readily available.

Study Characteristics. The introduction of the viewer-fiche system to the Spring quarter class affected student study methods in several ways, the most obvious being the redistribution of study time. The availability of information made data acquisition much less demanding and allowed more time for home study and review. In some cases, this led to better preparation on a daily basis with less need to "cram" for examinations; in other cases, the result was a tendency to put off the readings since material was always available. The viewer-fiche system allowed students to study according to their individual preferences without the constraint of the library reserve system.

Problems of xeroxing, underlining and note-taking were identified. Some students stated that they would have made xerox copies of the material on the fiche if it had been possible but over half of the students felt that they would never have xeroxed materials anyway. (The latter opinion is consistent with the Winter quarter experience.) These students stressed the fact that they already had the materials in fiche form and xeroxing would have been superfluous. Several students would have liked to obtain permanent copies of specific materials because of personal

interest only. Some students would have used a selective copying technique to retain important passages and to underline material or make notations.

Seven students expressed dissatisfaction at not being able to underline or write on the fiche itself. Students who have previously used underlining as a primary study method were required to change when using the reader presentation (students who used note-taking or read-and-reread could continue to do so). This indicates a constraint of the viewer-fiche approach to information utilization; having information available on fiche decreases the need for note-taking to obtain materials, but it leaves no way to emphasize points of interest unless the students write them down (which is less convenient than underlining or making marginal notations). The note-taking process itself caused difficulties for five students using readers since it is necessary to re-locate a position within the presentation as one moves from the paper to the screen and back. This is very difficult for students who use reading glasses, especially bifocals. These problems are accentuated by poor viewer location within a study area, and the vertical screen position.

Fatigue Characteristics. In response to the post-class questionnaire, most students indicated that using the viewer-fiche system resulted in physical and/or eye fatigue; five indicated eye fatigue, two physical fatigue, and three both physical and eye fatigue. Comments indicate the primary cause of eye fatigue was the small sized print; physical fatigue was associated with restrictions imposed by the viewer-fiche configuration itself. Limited work space and the size of the viewer made it difficult to alter the physical position of the viewer so that students were forced to maintain a rather consistent posture to use the system.

Responses, of course, do not indicate whether the fatigue from use of microform was more than would have been encountered using hardcopy. Further, the percentages are based on students' subjective feelings of fatigue since measures of objective fatigue manifest in performance decrement were not available. Although fatigue was present using the viewer-fiche presentation (as in any extended reading task), the students were sufficiently motivated to complete the required readings and meet course requirements.

Organization of the Fiche. Microforms designed for use in direct support of a particular course must meet specific, structured information needs as defined by the instructor; these information needs provide the only motivation for routine student use of the filmed materials and they should be organized and indexed in the way which most adequately and conveniently meets these needs.

In most classroom situations, a specific order of reading is imposed by the instructor in conjunction with classroom discussions and examination; this order should be followed precisely on the fiche. If such order of reading is not established, the fiche should relate materials which have a common theme or present competing points of view. This type of organization was recognized by the majority of students in the present study. It was emphasized since periodical articles were on a separate fiche, and students often had difficulties in locating a specific article on the periodical strip. Seven of the students expressed the desire that the periodical articles be included in each week's readings.

Another important consideration is proper indexing. Each film strip contained an eye-legible index locating by segment the readings on the strip, but the limited space for this indexing prevented listing individual periodical articles on the sixth strip. This omission, coupled with the separation of these articles from the remainder of the study unit, resulted in difficulties, even though the articles were organized in the order in which they were to be read. The eye-legible index on the first strips was adequate for most students when used in conjunction with a hardcopy index (the syllabus) which was also provided, but some indication of what each column contains and where the user is within a segment or strip should be included within the fiche material itself.

Directional formatting was posed as a question; five students preferred the better-known horizontal format, four preferred the vertical, and two had no preference. (It is important to note that students were not given a choice or a comparison between formats; all material was presented vertically.) Preferences for horizontal formatting were based equally on a supposition that it would make the presentation more "book-like" and that some viewers were easier to adjust horizontally, although students who preferred vertical formatting cited similar viewer adjustments to some extent. Vertical preferences were based primarily on the ability to maintain more continuous eye contact with the text using the vertical format; students used the presentation in a scroll-like manner with the bottom half of one page and the top half of the following page on the screen at the same time so that they did not lose eye contact

with the reading material at the end of each frame. (A format comparison would have made this advantage more obvious to all the students.) Since course performance was not adversely affected by microform use, it can be concluded that there was no basic or unanticipated problem associated with vertical formatting of the materials.

Student Criticisms and Recommendations

1. A common complaint was that the print-size of several articles was too small. It was recommended that materials originally printed in small type (8-point or less) be avoided or redone in larger type.

2. The majority of the students found difficulty with the vertical screen presentation and recommended that the viewer screen be positioned at an angle, particularly for students who require glasses for reading. Several students suggested a horizontal screen position integrated into a work surface.

3. Several articles were difficult to locate, especially on the periodical fiche; more care in indexing was recommended.

4. Students complained of difficulty in maintaining hard focus on the viewer screen without constant adjustment, this being especially true while scanning but also occurring in normal frame-to-frame operation. It is essential that hard, uniform focus be maintained in the operation of the viewer.

5. It was difficult to alter the physical position of the viewer in the study area due to size and bulk. A more portable viewer for home use or a movable viewer integrated into a study carrel was recommended.

6. Note-taking was difficult; it was thought note-taking would be easier with a less-vertical screen position so that side-to-side spacial relationships could be established between the viewer screen and notebook.

7. In addition to these criticisms, many students mentioned that for viewer use at night, when most home study is done, note-taking problems are compounded when no effective source of ambient lighting is provided within their study

area. The screen presentation has a tendency to "jump out" at the user. The provision of proper ambient illumination was not easily accomplished since a light placed behind the plane of the viewer screen distracts the user; a light placed behind the user is reflected on the screen and causes a glare. A soft light above the work surface or to one side of the presentation was recommended but this is not always possible in makeshift study areas provided by students for accommodation of a viewer. This problem speaks to "total" viewer design.

CONCLUSIONS AND RECOMMENDATIONS

With only the personal availability of reading materials for a course as the incentive, students did use a viewer-fiche system routinely to meet the requirements of a graduate course in library science; however, only half of the students using microforms felt that the essentially complete information availability compensated for deficiencies in the system. Future applications of microform in this context should assure students of complete information base, highly readable displays, and viewing equipment designed to facilitate the study task.

Microform was used continuously by students over the entire period of the experiment; most students continued to use the system after they became familiar with all aspects of the presentation because of the "value" of the information units and the convenience of the viewers. The level of use at the end of the course was as great as or greater than at the beginning.

Students using the microform system averaged less time per transaction initially than students using the library's reserve book system; obviously, the information personally available on fiche obviated the necessity for taking extensive notes for future study and review. Less time was spent with book materials as the course progressed, for students using the reserve book system, indicating the use of already acquired materials for review; whereas, students using microforms increased their transaction time, though generally maintaining a more constant level of contact with the reading materials throughout the course. Obviously, these latter felt less need for extensive abstracting of materials which were continuously available to them on fiche. Review work was quite apparently performed on the viewers by students using the microform system, whereas the students using the reserve book system utilized their notes for review. Achievement, as demonstrated by examinations, showed no significant differences between the two groups.

The overall student response to the microform system was positive; a conclusive majority said the home viewer and fiche materials fulfilled their home study needs and that they would like to see continued or expanded use of such a presentation even though modifications were needed to correct technical difficulties. Students criticized the upright screen position which made note-taking difficult, the lack of <u>hard</u> focus on the viewers, and inadequate indexing within the microform materials.

This experimentation has substantiated that students can and will use microform over extended periods, but a qualification to this result must be well understood: the need for new viewing equipment designed for study purposes is crucial. Clearly, the accommodations required of the students in order to utilize the microform display are substantial and work against acceptance. The major thrust of a design effort should be to achieve constant, hard focus over the whole screen image as well as from frame to frame. In addition, the display screen should be spacially oriented so that note-taking and use of other materials can be accomplished in a side-to-side relationship with the presentation, so that the user's eyes move laterally from screen to work surface rather than up and down. Such an embodiment implies a low screen angle, approaching the horizontal, instead of a screen on a vertical plane. One design possibility that should be pursued is the combination of a film viewer and work surface into a single unit in order to accommodate both the physical requirements of image projection and the required spacial relationships necessary to study tasks.

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